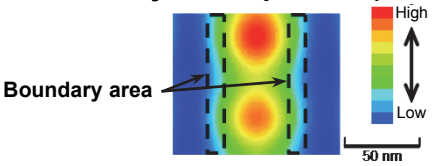
Structural analysis of photoresist at boundary area in resist pattern

It is very important for further miniaturization of semiconductor devices to investigate correlation between chemical structure of resist and Line Width Roughness (LWR). In this study, a novel sampling technique and Pyrolysis-GC/MS combined with micro-GPC enable usto analyze chemical structures of resist pattern in detail.

Approach for LWR analysis

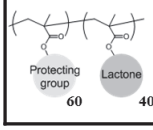
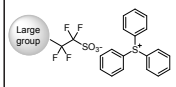
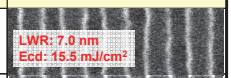
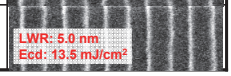
Optical intensity in L/S pattern (simulation)



・The optical intensity was dramatically changed at **boundary area**.

The resist pattern at boundary area was analyzed.

Samples

Polymer	PAG	Illumination	Lithographic performance (70nmL/40nmS)
		Annular	
		Dipole	

Problems

①How to collect the resist at boundary area?
②How to analyze small amount of the collected sample?

Novel method for the analysis of resist pattern

Solution①: Establishment of sampling method

・The solvent in which resist-components moderately dissolve is selected.

・The boundary area (surface) of resist pattern is collected by soaking in organic solvent for a short time.

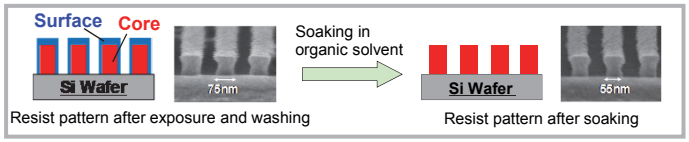
Solution②: Application of micro-GPC

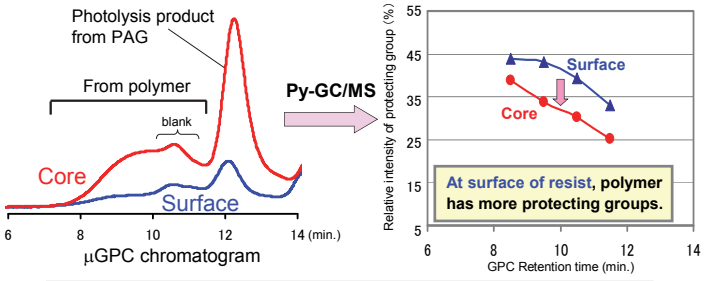
・GPC Fractions are dropped on sample plate or cup directly. Accordingly it is easy to be applied to IR, Pyrolysis-GC/MS (Py-GC/MS) and MALDI-MS measurements.

・Injection volume: **tens of micrograms**.

Results of analysis for resist pattern

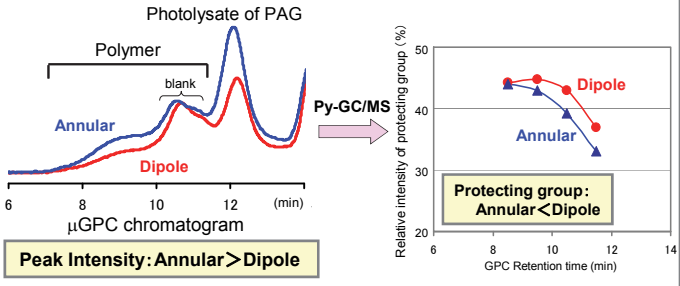
Comparison between core and surface (boundary area)





Information for boundary area was obtained.

Comparison between illumination conditions (surface)



Peak Intensity: Annular>Dipole

<Features of Annular>

From GPC measurement

More polymer were dissolved.
⇒ The boundary area was wide.

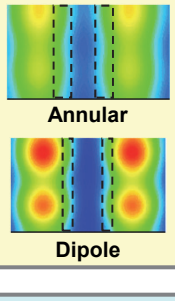
From Py-GC/MS measurement

Deprotection reaction more proceeded.
⇒ This area was illuminated halfway.

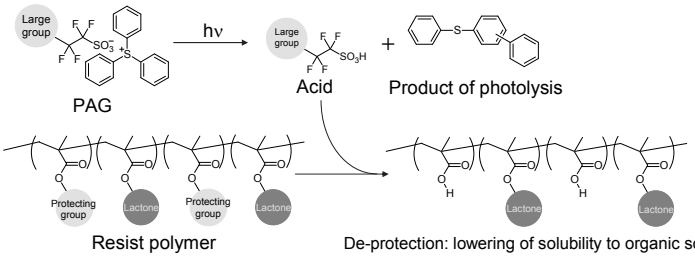
The optical contrast was low.

These results were consistent with simulation result.

Simulation



Reaction mechanism of resist



Conclusion

A novel method for the direct analysis of the boundary area in resist pattern was developed.

The difference of the optical contrast at boundary area was related to the actual chemical structures.

"Joint study with JSR Corp."